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Documentation of Lipote (*Syzygium Polycephaloides* (C.B. Rob.) Merr) and Respondents' Knowledge and Experience towards Ecological and Economical Usefulness

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Abstract

Lipote is a native fruit tree that needs promotion and protection due to its usefulness. This species inhabits the lowland forests of the Philippines and faces the risk of becoming endangered. Documenting Lipote could serve as a baseline for determining the optimal timing for fruit and seed collection, aiding in preservation and tree planting efforts. Also, this study helps to promote the contribution of Lipote ecologically and economically to call out communities who were not aware and familiar in the species to value, conserve and protect native fruit trees and natural resources, to provide support from the government and non-government sector by including Lipote in their reforestation projects emphasizing the importance of conservation efforts to save them from scarcity. Additionally, assessing its ecological and economic significance provides valuable baseline data for the government and other institutions to support the promotion, market potential, protection, and conservation of Lipote. Thus, this study was conducted to document the development phases of Lipote and determine the economic and ecological importance, as well as its usefulness. Documentation of Lipote was performed through daily observation of chronological events of Lipote reproductive parts by the researcher, supplemented by interviews with respondents using a structured questionnaire. In data collection, purposive sampling was used to select the ideal respondents with familiarity, experience and knowledge of Lipote. This was followed by interviews using a structured questionnaire to obtain a comprehensive understanding of its economic and ecological benefits. Lipote bears fruit annually, typically once to three times a year, depending on environmental conditions. It is recommended to conduct further studies on the documentation of Lipote outside Aurora Province, as its growth and fruiting patterns appear to be influenced by local environmental conditions. Various benefits of Lipote have been experienced by tree owners; however, there is a lack of appreciation for its ecological and economic importance.

Keywords

Lipote (*Syzygium polycephaloides*); Anthesis; Flowering; Reproductive development; Seed year

Introduction

The Philippines is home to a wide variety of indigenous fruit trees (IFTs) and is recognized as a center of origin for tropical fruit species. There are more than 300 edible fruit-bearing tree species in the country, and more than half are indigenous and endemic (Dulay *et al*., 2023). Among woody flowering plants, *Syzygium* is one of the largest genera, comprising 1,200 to 1,800 species naturally found in subtropical and tropical regions of Africa and Madagascar, with a wide native distribution across Asia and the Pacific region (Ahmad *et al*., 2016). The forests of the Philippines are home to many lesser-known fruits and vegetables that are rich in nutrients and hold significant economic potential. One such species is Lipote (*Syzygium polycephaloides*) that are known to contain high antioxidant properties and other health promoting and disease preventing compounds (Estacio *et al*., 2020). The preservation of Lipote has been prioritized in some areas in the Philippines, like in Laguna and Samar. The fruit can be eaten fresh and can be sold for about US$0.65/kg (Castillo *et al*., 2003). Lipote is naturally grown in the provinces of Aurora, Quezon, Bicol, Laguna, and Samar, where the local communities are known by other names as Igot, Bahang and Baligang (Cayetano *et al*., 2023). The landscape of Aurora is predominantly mountainous, with flat areas irregularly distributed across the province. It is estimated that Aurora has 236,804 hectares of public forestland, with 228,649 hectares classified as timberland, some of which are part of the Sierra Madre range (Llait, 2024). Alluvial deposits, basalt, and andesites are among the various soil types found in the region. Whereas quartz and silica are found close to beaches, igneous rocks are common in mountainous and hilly areas. The most common type of soil in the province is the loam soil. Among the 8 municipalities in Aurora, Baler is the center of tourism with the smallest land area, with a surface area of 5,175.33 ha or 46.42%. This area is made up of fruit-bearing trees, forest trees and cash crops (Gallego, 2024). Fruit trees offer numerous benefits to local communities by providing food, livelihood opportunities, and medicinal resources. They contribute to poverty alleviation, enhance nutrition and food security for the growing population, and play a crucial role in promoting soil and water conservation (Dulay *et al*., 2023). Unfortunately, some native fruit species are considered neglected and underutilized, despite their great potential for both local and international markets. Among banana, pineapple, mango, citrus, and papaya, Lipote is considered an underutilized fruit tree in Aurora due to its limited fruit supply, low familiarity with the species, and lack of knowledge regarding its use in food and medicinal preservation. In other regions like Quezon, Tayabas, Palawan, Nueva Ecija, and Isabela, Lipote is processed into wine, jam and jelly, providing a potential source of income for those involved in its production (Dionglay *et al*., 2022). However, there is no permanent potential local market for Lipote. Therefore, many researchers may recommend exploring the benefits of Lipote, from its processing and manufacturing to product development and nutritional analysis. This could encourage consumers and entrepreneurs to create a variety of Lipote-based products, ultimately helping local communities generate income (San Juan, 2023). According to Vallesteros *et al.* (2023), Lipote is good for reforestation, being highly adapted to environmental stress and can grow and develop under different soil types. However, Gregorio *et al.* (2017) stated that Lipote has the potential to become endangered due to deforestation, encroachment of invasive species, and lack of commercial popular varieties (Cabansag, 2016). In addition, the Philippines faces challenges in terms of seedlings used for reforestation

because of the limited production of good-quality seeds and poor performance of seedlings planted within the areas. Reproductive stages of native trees, especially in seasonal environments, are correlated to climatic conditions, which can influence the viability of seeds. According to Nautiyal, Sivasubramaniam and Dadlani (2023), the mother tree's environmental conditions experienced can influence the dormancy level of seeds, especially when the plants are exposed to low temperatures. The seasonal timing of plant life cycle activities like germination, leaf flushing, anthesis, flowering, and fruiting is influenced by climate change, inter-annual variations, and habitat conditions. In the plant life cycle, flowering is one of the most important characteristics because this is the initial process of a plant reproducing. Kamsurya *et al.* (2022) believe that the plant has different behavior in flowering and fruiting, but it ends with fruit maturity when the appearance of flowering buds starts to develop. However, it might be influencing the continuity of the stages by the surrounding environmental conditions such as temperature, irradiation and humidity. The variations in the onset of the phenological phases of tree species are considered reliable indicators of environmental change (Singh and Kushwaha, 2006). According to a field observation conducted by Nadarajan and Pujari (2019) in *Syzygium caryophyllatum*, the total period needed to complete the entire process of fruit formation was 110–118 days. *Syzygium stocksii* has an asynchronous fruiting pattern that takes 89 days to complete phenological growth stages using BBCH (Pawar *et al*., 2023). A similar duration was observed in the synchronous fruiting pattern of *Syzygium paniculatum*, which has taken 89 days to complete the flowering development phases using BBCH (Ramírez and Kallarackal, 2019). Therefore, the aim of this article was three folds: to document the duration development of flowering phases of Lipote, to determine the duration of flushing, anthesis, flowering, fruiting and fruit fall based on the observation of the selected respondents and to document the knowledge and experience of the selected respondents about economic and ecological importance of Lipote in Baler Aurora.

Methodology

The main purpose of the study was to document the development duration of Lipote and to reveal the knowledge, attitude and perspective of the selected local community in Baler towards economic and ecological uses and importance. The descriptive statistics were used to analyze the response of selected individuals. The design is efficient in qualitative data to summarize and organize data into a form that is easier to understand (George and Mallery, 2018). The interview/questionnaire method was used to gather information from the respondents. According to Harris and Brown (2019), the interview questionnaire method provides detailed insights and a more comprehensive understanding of the research topic.

Study Area

The documentation of Lipote's flowering development was conducted in Barangay Zabali. The site meets the criteria for selecting monitored trees, which are accessible for regular monitoring, have good visibility of phenological structure, are stable and free of disease and are not impacted by human activity. The observation frequency was done day by day on a regular basis. While interviews with respondents took place in Barangays Buhangin, Calabuanan, Pingit, Suklayin, and Zabali in Baler, Aurora. The

southeastern part of Baler is predominantly mountainous and classified as forestland, constituting the largest portion of the area. In contrast, flat areas are primarily found in the northwestern portion and are mostly considered alienable and disposable land (Figure 1).

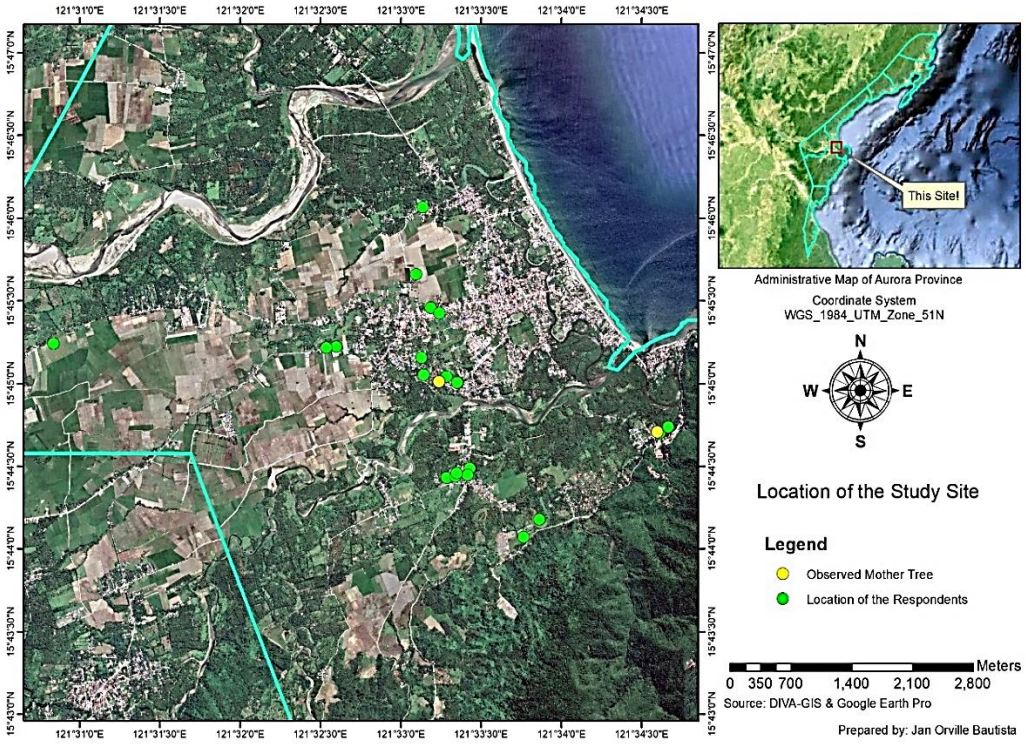

Figure 1. Map of the location of the selected mother tree documented and respondents in Baler, Aurora, generated using ArcGIS 10.8

Selection of the Respondents

This study applied a non-probability purposive sampling method, convenience and snowball sampling methods to identify the respondents from selected barangays. Purposive sampling is a research technique in which participants are selected based on specific traits, knowledge, experience, or criteria (Campbell *et al*., 2020). The criteria for selecting the respondents were limited to those residents at least 30 years old and with 10 years of experience in the consumption and extraction of Lipote, based on the considerations that they are more knowledgeable and experienced in terms of development, importance and usefulness of Lipote. Snowball sampling was employed to identify other potential tree owners based on the following criteria: familiarity and knowledge in Lipote with 10 years' experience in consumption and conservation. The total respondents was identified by getting 100 percent of the total tree owners in the selected barangays. There were 18 tree owner participants, and 5 of them are key informants coming from different barangays.

Data Collection Instrument

To gather the necessary information for this study, the materials used included a camera to document the daily flowering phases of Lipote from anthesis to fruit maturity, a GPS device for tagging specific trees on particular dates, and an interview questionnaire. The questionnaire consisted of two parts. The first part focused on determining the timing of flowering development of Lipote in terms of period of flushing/bolting, anthesis, flowering, fruiting, fruit maturity, harvest period, leaf fall if deciduous and other activities that can be specified. The first part also included observation of the respondents on any seed year, gregarious fruiting, as well as specific soil, habitat and climatic requirements of this species, the area where the species thrives, and the amount of fruits harvested in one period were also asked. The second part of the questionnaire was focused on the economic and ecological importance and uses of Lipote. It tried to elicit from the respondents the (1) need to conserve fruit trees of Lipote, (2) usefulness of Lipote to their respective household, communities and ecosystem, (3) parts of leaves, flowers and bark of Lipote and their respective uses and (4) where Lipote usually grows (site location/site description).

Data Collection Procedure

Before the actual conduct of this study, the researcher submitted a letter of request to the Local Government Unit in the Municipality of Baler to conduct the study on the documentation and importance of Lipote. The researcher also provided a request letter to conduct interviews with the heads of different offices, such as DENR (PENRO and CENRO), the School of Forestry and Environmental Science and Barangay Captains of the respective barangays.

Data Coding and Analysis

Coding is employed to systematically categorize and analyze textual data, allowing researchers to identify patterns, themes and meaningful insights within complex, non-numeric information (Williams and Moser, 2019). In vivo coding was used to analyze the respondent's descriptive response, which is a qualitative data analysis technique, uses the exact words and phrases of interview participants as codes. However, some questions in the structured questionnaire obtained direct answers from the respondents, where it does not need to be coded. The interview transcriptions were coded thematically, in an iterative process which aimed to identify the ecological and economic usefulness of *Syzygium* (Table 1).

Data Analysis

Data were gathered through questionnaires using a non-probability purposive sampling method were recorded and organized in Microsoft Excel for analysis. Descriptive statistics, including means and percentages, were used to analyze the data. Respondents' observations on the timing of flowering and fruit maturation in Lipote were used as a reference and compared with the researcher's actual documentation of the species' developmental phases.

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Table 1: Coding Framework with Examples

Themes coded	*Examples*
Reason for conserving Lipote	
Source of nutritious foods	• It provides fruits to sustain our hunger • The tree provides a lot of fruits, and we consume them because this tree gives us additional nutritious food sources in our family.
The population of Lipote is declining.	• There are a few species of Lipote in Baler that I've seen. • The population of Lipote is declining due to lowland areas are prone to land use change for development which Lipote is rarely found in this area. • Lack of government support for using planting materials for reforestation
Usefulness of Lipote in households, communities and the environment	
Provides shade, food and income	• Lipote offers food and income by providing nutritious fruits that can be sold to our neighbours • Provide income by selling fruits to the students who want to study the seed propagation of Lipote for their laboratory. • Lipote gives shade due to having large leaf sizes, and simultaneously, it brings income and food to us.
Provides windbreaks against strong winds	• Lipote gives us protection against typhoons because it was still standing after strong winds. • Serve as windbreaks due to their tall heights, which helps to protect our crops against strong winds and typhoons.
Source of fuel wood and soil fertilizer	• We use dry branches of lipote as fuelwood, and the dry leaves are left in the soil to become nutrients and help the soil become fertile.

Results and Discussion

Documentation of Lipote

Lipote trees inside the vicinity of Aurora State College of Technology, Zabali, Baler, Aurora were observed. These trees had an average total height of 15.5m. The observed habitat of Lipote is characterized by low to medium elevation (34.4 masl) within a forested area, with sandy and loamy soil types having a high moisture content. The leaves of Lipote are broad with alternate arrangement and decurrent canopy with no activity of leaf shedding. Its fruit is fleshy and found along the branches, known as ramiflory. The color of the exocarp of an unripe fruit is green and turning red and purplish to black upon maturation, with a white mesocarp. The seed possesses soft and

thin testa. The outer bark of the tree is smooth and purplish gray. It has an asynchronous type of fruiting development, resulting in several fruit colors due to heterogeneous developmental stages of its flowers and fruits. The month of gregarious fruiting of Lipote is from September to December. Moreover, this species produces fruits twice a year in the months of March and September. The developmental stages of Lipote were divided into 12 stages, which lasted within 106 to 141 days, starting from the emergence of flower buds up to fruit ripening (Table 1).

The developmental stages of Lipote were divided into 12 stages, which lasted from 106 to 141 days, starting from the emergence of flower buds up to fruit ripening (Table 2). The first stage began with the emergence of potential flower buds on the twigs (Stage 1), which lasted about 12 to 14 days. The second stage (~ 14 to 16 days) started when the stalk began to elongate and showed a second branching (Stage 2). The next stage (Stage 3) exhibited lengthened inflorescences and further development of more flower buds. Subsequently, the fourth stage started when the branches became visible (~20 to 25 days). The fourth stage was indicated by the enlargement of the flower buds and by the peduncles that stop elongating after 10 to 12 days. The fifth stage started when the perianths became showy and the flower buds turned into an ovoid shape. This indicated that the flower buds were about to bloom in 4 to 8 days. At this stage (Stage 6), several tepals opened, revealing the stamens and pistils, and the flowers began blooming within 5–10 days. Stage 7 marked the full bloom of white flowers, with stamens and pistils that appeared together with the open tepals for 4 to 5 days. Stage 8 was marked by enlarged ovules, falling stamens, and tepals off, and the basic shape of the flowers started to become visible for about 7 to 9 days. Stage 9 was characterized by enlarged flower bases and the formation of fruits until young fruits had a purplish-green color, which usually turned ripe within 7 to 10 days. The development of unripe fruit was observed until the green color fruit is completely developed for about 10 to 12 days (Stage 10). The semi-ripe fruit development started when the green fruit completely turned red and then a purplish color. This is where the seed embryo is under development for around 8 to 10 days (Stage 11). In the last stage, the fruits were completely ripe, red turned black and had a round shape and already contained mature seeds, which lasted 15-17 days.

Table 2: Lipote stages of flower and fruit development

Stage	*Flower, Fruits, and Seed Descriptions*	*Picture of Stages*	*Duration (days)*
1	Emergence of buds. Flower buds start to emerge.		12-14

2	Extension of peduncles. The peduncles start to extend until they show second branching.		14-16
3	Elongation of inflorescence. The inflorescence was lengthening, and more flower buds emerged, then there was extension of the peduncle until the multiple branching was visible.		20-25
4	Enlargement of flower buds. The peduncle lengthens, and there is an enlargement of flower buds.		10-12
5	Showy perianths. The flower buds began to develop until they are perfectly ovoid, showing the perianths/tepals, and the flower buds are ready to bloom.		4-8
6	Flowers started blooming. Some of the flower buds bloomed, marked by the opening of some tepals and the appearance of stamens and pistils.		5-10

7	Flower perfectly blooming. The flowers were perfectly blooming and completely open, white, the stamens and pistil appeared simultaneously with the open tepals.		4-5
8	Enlargement of ovules. Tepals and stamens fell off, showing the flowers' basic shape, which contained the ovule and pistil at the end part; ovules started to enlarge.		7-9
9	Fruit formation: the base of the flowers was enlarged, fruits started to form, young fruits formed a round shape and a green color.		7-10
10	Fruit development. The unripe fruit develops is more pronounced round shape, and the green color is seen. It is now gradually starting to change in color from green to purple.		10-12
11	Fruit ripening. The semi-ripe fruit is completely turning red and is becoming purplish.		8-10

12	Complete fruit ripening. The fruits were completely ripe, becoming soft, black and rounded, and the seeds are now mature.		15-17
Total time observed			116-148 days

The twelve developmental stages of Lipote, as given in this study, can be further summarized into six stages, namely, the evocation or flower induction, flower initiation, flower development, anthesis stage, pollination and fertilization, fruit development and seed formation. These stages are almost similar to the stages of *S. myrtifolium* as described by Mudiana and Ariyanti (2010), but different stages in Indian blackberry (*Syzygium cuminii*) where it has 40 secondary growth stages and have been define with seven principal growth stages (Kundan, 2019), although a more detailed description is provided here.

Figure 2 shows the flowering stages observed in Lipote. The first stage, which is the flower induction, was not personally observed. Syamsuwida *et al*. (2012) observed various stages of *Melia azedarach* L. and found that flowering induction happened a month before the emergence of flower buds. Moreover, anatomical observation during this stage is necessary in observing flower induction because this stage occurs at the cellular level. As observed, the bursting of buds before the emergence of flower buds took about 12 to 14 days. The second stage is the flower initiation, which took 26 days, characterized by the emergence of the flower bud. Stages 3 to 6 of the flower development are the longest process that takes 39 days on average. The shortest floral process of development was the antithesis by (stage 7), which lasted 4 days. Stage 8, which lasted approximately 7 days, marked the beginning of pollination and fertilization. Fruit development and seed formation (stages 9 to 12) are the last phenological processes in the reproductive cycle of Lipote, which took more or less 33 days. Similar studies were conducted in various *Syzygium* species, including *S. pycnanthum* (Mudiana and Ariyanti, 2010), *S. guineense* subsp. *macrocarpum* (Djoukeng *et al*., 2005), *S. hirtum* (Haro-González *et al*., 2021), *S. cumini* (Ramya, Neethirajan and Jayakumararaj 2012), and *S. caryophyllatum* (Stalin and Swamy, 2018) exhibiting varied outcomes. *S. pycnanthum* required 80–89 days to go through the entire flowering period, while 116 to 128 days are needed to complete the *S. caryophyllatum* development of the flowering period in *S. guineense*. Additionally, *S. hirtum* needed 95-105 days, *S. cumini* required 186-196 days, and needed 63-78 days.

Flowering/Fruiting Month

The reproductive development of Lipote started during April and May, where bolting and shoot development occurred. Moreover, an anthesis happened in the month of June while flowers started to bloom in July, but not all the flowers had bloomed. Based on the observation, only flowers visited by the pollinators, such as bumble bees, white

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albatross, and Apidae, successfully developed into fruits. After flowering, fruiting development started in the months of August and September. In the month of October, the fruits were mature and ready for harvest. Thereafter, the fruits started to corrugate before the fruit fell in November. As observed, there is no aggregate leaf shedding in Lipote. Thus, it can be considered as evergreen. Table 3 shows the observation of the respondents regarding flushing and bolting, anthesis, flowering, fruiting, fruiting maturity, fruit fall, and leaf fall.

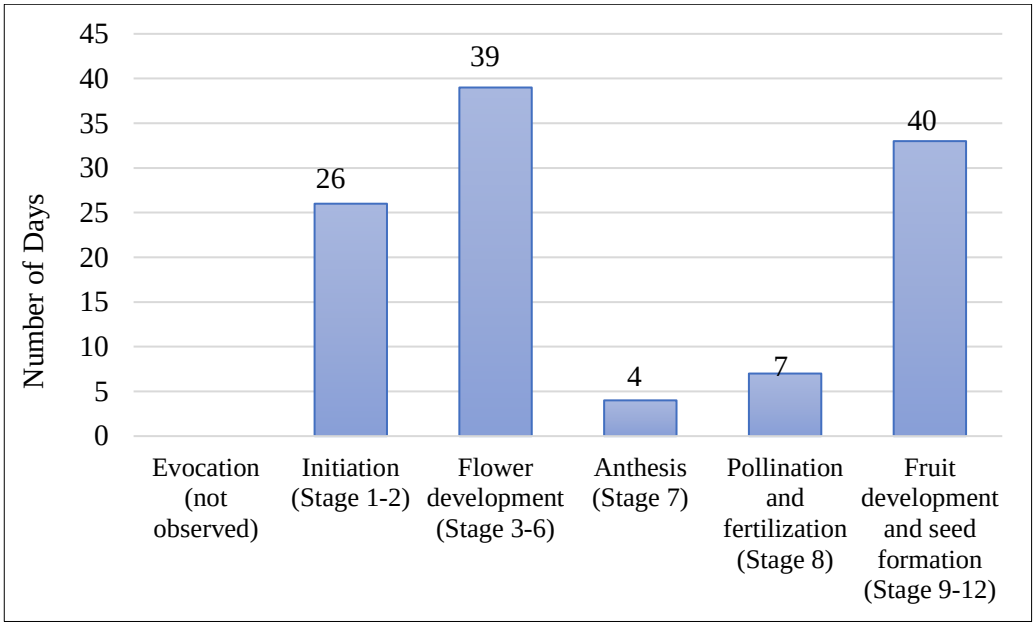

Figure 2: Average number of days for each flowering stage of Lipote

Based on their observation, 61% of the respondents observed that flushing and bolting season was from January to March, 33% of the respondents observed it in May to July, and 6% of the respondents observed it in the month of September. Similarly, 61% of the respondents observed that anthesis occurred in March to May, 27% respondents observed this in August and September, and the remaining 12% of the respondents observed it during July, October, and November. In terms of flower development, 39% of the respondents observed it in May, 28% of the respondents observed it during October, 22% of the respondents observed it in the months of June and July, and only 6% of the respondents observed this in the months of August and September. For the fruit development, the months of June and July had the highest percent observation with 44%, followed by the months of November and December with 28%. Moreover, 22% of the respondents observed fruit development in August and September, and only 6% of the respondents observed it in January to March. In fruit maturity, the highest observation percentage of respondents (44%) was in the month of August. Meanwhile, 22% of the respondents observed fruit maturity in January, October, and November, while the remaining 12% of the respondents observed fruit maturity in the months of April, May, and December. In terms of fruit fall in Lipote, 28% of the respondents observed that its occurrence was in the month of September, while 17% of the respondents observed it in the months of February and October. Moreover, 11% of respondents observed fruit fall in November and December, and lastly, 18% of the

respondents observed fruit fall in January, March, June and April. Moreover, the respondents did not observe shedding of leaves in Lipote.

Table 3: Respondents' observations on the stages of development of Lipote

Stages of Development	*Period of Months*	*Frequency*	*Percentage (%)*
Flushing and Bolting	January to March	11	61
	May to July	6	33
	September	1	6
Anthesis	March to May	11	61
	August to September	5	27
	July to November	2	12
Flower Development	May	8	44
	October	5	28
	June to July	4	22
	August & September	1	6
Fruit Development	June to July	8	44
	November to December	5	28
	August to September	4	22
	January to March	1	6
Fruit Maturity	August	8	44
	January, October & November	4	22
	April, May & December	2	12
Fruit Fall	September	5	28
	January to March	3	18
	June & April	3	17
	February & October	2	11
	November & December	5	28

Baler Aurora is a province where an experienced tropical rainforest climate with high temperatures and humidity and significant rainfall throughout the year, with no dry season. The different timing of the flowering process is likely due to the external factors such as light, temperature, water, nutrients, and microbes' pollinators (Vasconcelos *et al*., 2009). Similar factors were identified by Aguinaldo and Read (1990) in Balukbok (*Microcos philippinensis*). In Mt. Makiling in Laguna, the flowering of Lipote occurs in December, and ripe fruit can be harvested in July (Flandez *et al*., 2021), while Lipote trees in Quezon province usually bear flowers in January and February. Fruiting and collection of fruits can be observed mainly in June and July, and August, respectively (Florido and Cortiguerra, 2003). However, some trees did not follow the usual timing of these stages, most likely due to environmental factors having different climatic types. The municipality of Los Baños in Laguna province has the climatic type of tropical monsoon, while Quezon Province has climatic type III and Aurora Province have a tropical rainforest climate. As observed by the community and the researcher, Lipote had no particular seed year, and it produces viable seeds every year. It also bears fruit twice a year if the weather is favorable for fruit development. All the respondents, including the researcher himself, had observed that Lipote can bear viable fruits and seeds annually.

Table 4 shows that 67% of the respondents observed that Lipote thrive in sandy and loamy soil. Meanwhile, 17% of the respondents observed the species in sandy soil, 11% in forest soil, and only 6% of the respondents observed Lipote in clay soil. As observed by the researcher, Lipote are mainly found in sandy soil with a mixture of loam soil and forest soil, which was a product of the performed soil sedimentation test. *Syzygium* species grow in a variety of soils and geographical formations such as alluvial, lateritic, sandy alluvia, marl, and olitic limestone, while some of its species can tolerate saline soil and can even be found in deep, rich well well-drained soil (Nigam and Nigam, 2012).

Table 4: Soil type requirement of the habitat of Lipote as observed by the respondents

Specific Soil Habitat	*Frequency*	*Percentage (%)*
Sandy and loamy soil	12	67
Sandy soil	2	11
Forest soil	3	17
Clay soil	1	6

Table 5 presents respondents' observations on Lipote's habitat. About 61% reported that Lipote thrives in low forests, 11% observed it in wetland areas, and only 6% noted its presence in agricultural lands. However, 22% of the respondents were not able to determine the preferred habitat of Lipote. Based on the observation of the researcher, this species can be seen mostly in the open canopy with warm and moist conditions, along rivers, low elevation forest, grassland, agricultural land, wetlands, and sites with high moisture conditions based on the moisture meter. According to the Santiago *et al.* (2007), Lipote are mostly found in primary forest but can also be cultivated in home gardens with low to medium elevation. Similar to the observation of Cayetano *et al*. (2023), this species is usually found at low and medium altitudes in forested areas.

Table 5: Specific habitat of Lipote as observed by the respondents

Specific Habitat	*Frequency*	*Percentage (%)*
Low forest	11	61
Agricultural lands	1	6
Wet areas	2	11
Not observed	4	22

Table 6 presents the climatic requirements of Lipote. About 28% of respondents observed the species in areas with moist and warm air, while 22% noted its presence in high-moisture environments. However, 50% of respondents were unable to determine their climatic preference. However, the researcher observed Lipote in moist areas. The result of this study is consistent with the observations of Laird, McLain and Wynberg (2010), which suggest that Lipote thrives in mildly cool climates with moist soil and can adapt to environments with temperatures of at least 10°C.

Table 6: Climatic requirements of Lipote as observed by the respondents

Climatic Requirements	*Frequency*	*Percentage (%)*
Moist and warm air	5	28
Areas with high moisture	4	22
Not determined	9	50

Table 7 shows the observation of the respondents regarding the age of Lipote before it can bear fruit annually. About 72% of the respondents observed that Lipote can bear fruits at the age of 5 years, followed by 10 years (17%) and 11% for 6 years. This is in support of the earlier study of Vallesteros, Banan and Ibarra (2023) in Lipote, wherein this species can bear fruit within four to five years after planting. Similarly, the study of Coronel (2011) found that Lipote can bear fruits 5 years after planting, like some other fruit trees such as rambutan, abiau and hagis.

Table 7: Age of the Lipote before it bore fruit, as observed by the respondents

Age	*Frequency*	*Percentage (%)*
5 years of age	13	72
10 years of age	3	17
6 years of age	2	11

Lipote produces fruits once or twice a year. The researcher observed the gregarious fruiting of Lipote every year in the month of September. Similarly, the respondents' observations about the gregarious fruiting characteristic. However, the months of observation in its fruiting vary (Table 8). Around 28% of the respondents observed gregarious fruiting in the month of September, 22% of the respondents observed this in August, 17% of the respondents observed it in December, 11% of the respondents observed it in July, and 6% of the respondents observed this in October.

There is no specific study about the exact timing of gregarious fruiting of Lipote. These results may be explained by the fact that Lipote produces fruits all year round, exhibiting an asynchronous type of fruiting which mostly depends on their ecological distribution. According to Lestari and Fiqa (2020) and Wibaux *et al*. (2024), asynchronous fruiting is influenced by combination of different environmental factors of abiotic and biotic like fluctuation of temperature which can disrupt normal development of fruit leading to uneven fruit ripening, incomplete pollination by the activity of seasonal pollinators resulted in asynchronous fruiting and even drought period can cause premature fruit drop and stunted growth. Lipote is mostly found in lowland forests, where the light captured is minimal, resulting in asynchronous ripening due to reduced fruit set. This is supported by the study of Flandez *et al.* (2023) that Lipote fruit can be harvested in the month of July, and by the findings in the study of Florido and Cortiquerra (2003) in the province of Quezon.

Table 8: Months of gregarious fruiting of Lipote as observed by the respondents.

Month of Gregarious Fruiting	*Frequency*	*Percentage (%)*
September	5	28
August	4	22
December	3	17
July	2	11
October	1	6
Not observed	3	16

As observed by the researcher, Lipote produced abundant fruits. Table 9 shows the fruit yield of a Lipote tree in one season. About 61% of the respondents usually gather 30

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kilograms of fruits per tree in one season for 5 years, and 17% of the respondents usually gather 50 kilograms. Meanwhile, some respondents have gathered 40 kilograms and 15 kilograms with 11% each. Fruit yield varies with age, location where it grows, site quality, height, and the branches of the tree. On the other hand, for its relative, *S. cumini*, *the* average fruit yield from a full-grown tree planted from seeds is about 80 to 100 kg, while for grafted tree can produce about 60 to 70 kg per year (Horticulture, 2022).

Table 9: Fruit yield of Lipote in one season as observed by the respondents

Yield (Kg/Tree)	*Frequency*	*Percentage (%)*
30 – 39 kg	11	61
50 kg	3	17
40 – 49 kg	2	11
15 - 29 kg	2	11

Economic and Ecological Importance and Uses of Lipote

The population of Lipote in Aurora is declining, with few remaining populations present in Baler, Aurora. Unfortunately, some residents of Baler did not know this species. Lipote contributes to local economies by encouraging the farmers to plant it, which can produce different products of nutritious dietary like jam, jellies, beverages, and prickles that can generate income through market sales while supporting local businesses and livelihoods in rural areas. Also, it possesses a medicinal property of antioxidants and antihypertensive. This variety of uses generates interest in the market and promotes industry for food and medicinal products, especially today, where the demand for functional food has increased significantly in recent years. Lipote is an indigenous fruit tree that plays a vital role in reforestation by restoring ecological balance and providing food and income for the local community, and enhancing biodiversity. The fruit of Lipote provides food for various species, especially the birds, while the flowers are essential to support pollinators like bees, butterflies, as well as birds for plant reproduction and to enhance biodiversity. Lastly, Lipote also plays a crucial role in conservation by supporting biodiversity, improving livelihoods and contributing to food security and ecosystem services. Table 10 shows the perception of the respondents on the reasons for conserving Lipote. Based on the respondents, 33% of them said that Lipote must be conserved since this species is a source of nutritious food. Some 22% said that Lipote needs conservation due to the continuous decline in its population, also highlighting its potential as a planting material in reforestation activities. Furthermore, 17% of the respondents believed that it is native fruit trees that offer habitat to undomesticated animals like birds and reptiles, thus, dictating the need to conserve them. Additionally, some respondents attested that Lipote needs conservation because this species is a source of herbal medicine, can absorb carbon dioxide, and can provide an additional source of income to those who harvest and sell fruits (6%). According to the Ecosystems Research and Development Bureau (2017), Lipote fruit contains rich amounts of carbohydrates and water, as well as vitamins A, B1, B2, B3, and C and essential minerals such as calcium, phosphorus, and iron.

Table 10: Reasons for conserving Lipote as mentioned by the respondents

Reasons for Conserving Lipote	*Frequency*	*Percentage (%)*
Source of nutritious foods	6	33
The declining population is used as planting materials for the reforestation project.	4	22
Offers habitat for undomesticated animals.	3	17
Increase the number of Lipote in the province.	2	11
Contributes additional income	1	6
Ability to absorb carbon dioxide	1	6
Source of herbal medicine	1	6

Table 11 shows the usefulness of Lipote to communities and the ecosystem, wherein 50% of the respondents testify that Lipote provide shading, food for humans and animals, and acts as a source of income due to its fruits. In addition, 22% of the respondents said that Lipote provide windbreak against strong wind and is a source of medicine to help address hypertension, chronic disorder, cancer and many more and also, it can absorb carbon dioxide and prevent soil degradation. Meanwhile, 6% of the respondents answered that Lipote can be a source of fuelwood and contribute additional nutrients to the soil since it produces an ample number of litters. Other than those, Lipote can be used as shade trees in urban settings. The respondents had significant knowledge and awareness when it came to the reason for conserving Lipote, as it can contribute to promoting this species in the locality. However, most of the community had low knowledge and familiarity with the species for some reasons that these species thrive by chance in their backyard, and the taste of fruit is not likely appreciated by everyone, leading to minimal promotion and potential market buyers. This must be addressed properly as a citizen of the country who must do their duties and responsibilities to protect and conserve the environment. Education Information and Communication (EIC) campaign for the environment can help to raise awareness, develop the community's practical skills to prioritize the welfare and status of the environment (Loseñara, 2020). Thus, the communities must be well knowledgeable about the economic and ecological importance of Lipote and other native species, including the environmental law. However, it is a good sign that some individuals are knowledgeable in Lipote, they can appreciate the provisioning, regulating and supporting services that help to prevent the threat of becoming endangered. According to Cayetano *et al.* (2023), Lipote is recommended as a tree shade due to the leaves that are resistant to moth larvae. Natural sweet fruits are usually eaten fresh or cooked into preserves such as jams and jellies or turned into beverages such as wines that can be sold to the market (Ecosystem Research and Development Bureau, 2017).

Parts of Lipote and Their Respective Uses

Leaves. Lipote has a broad type of leaves measuring 6 to 20 centimeters long. Table 12 shows the uses of Lipote leaves in the community. Most respondents (50%) said that Lipote leaves provide shade due to their large size and leathery texture, and the decurrent form of its canopy. Moreover, 28% of the respondents mentioned that dry leaves of Lipote can be used as organic fertilizers, while 22% of the respondents use Lipote leaves as medicine for cough. According to Ecosystem Research and Development Bureau

(2017), the Lipote tree is highly recommended as a shade tree for the reason that the leaves of this species are not susceptible to attack by the hairy caterpillar (*Amsacta albistriga*). Further, some people in Ifugao use Lipote leaf decoction in treating hypertension.

Table 11: Usefulness of Lipote in households, communities, and the environment as observed by the respondents

Usefulness of Lipote	*Frequency*	*Percentage (%)*
Provides shade, food and income	9	50
Provides a windbreak against strong winds	4	22
Source of medicine, absorbs carbon dioxide and prevents soil degradation.	4	22
Source of fuelwood and additional nutrients to the soil from litter.	1	6

Table 12: Uses of Lipote leaves as given by the respondents

Uses of Lipote Leaves	*Frequency*	*Percentage (%)*
Provided shades due to the broad size canopy	9	50
Dry leaves can be used as organic fertilizers	5	28
Medicine for treating cough	4	22

Flowers. Lipote flowers are numerous, white and in panicles. Table 13 shows the respective uses of Lipote flowers. The highest percentage of the respondents (33%) observed that the flowers of Lipote are a source of food that supports the activity of bumble bees, white albatross butterflies and Apidae insect survival. Moreover, 28% of the respondents said that Lipote flower offer aesthetic beauty, while 39% of the respondents did not know the uses of Lipote. Flowers of *Syzygium* genus valued for their nectar which attracts pollinators and is used to produce high quality honey (Badou *et al.*, 2020). According to Mbaveng and Kuete (2017), the unopened flower buds of *Syzygium aromaticum* (clove) are a commercially important spice, used for flavoring and medicinal purposes. There is limited study regarding the uses and importance of Lipote flowers in the community.

Table 13: Uses of Lipote flowers as given by the respondents

Uses of Lipote Flowers	*Frequency*	*Percentage (%)*
Source of food and provides ecological habitat for different insects (bumble bee, white albatross, and *Apidae*)	6	33
Provides aesthetic beauty	5	28
No answer	7	39

Bark. Lipote has a purplish gray bark. Table 14 shows the uses of lipote bark. There were 22% of the respondents who used Lipote bark as fuelwood, while 78% of the respondents did not use the bark of Lipote as fuelwood. The bark of Lipote contains alcoholic extract, and can yield active constituents like inorganic salts, carbohydrates,

and proteins. These extracts exhibit anti-bacterial and anti-inflammatory activities in female rats (Cayetano *et al.*, 2023), but the residents have not explored much on the uses of Lipote bark.

Table 14: Uses of Lipote bark as given by the respondents

Uses of Lipote Bark	*Frequency*	*Percentage (%)*
Additional contribution for fuelwood	4	22
No answer	14	78

Roots. Table 15 shows the respective uses of Lipote roots wherein 56% of the respondents testified that the roots of Lipote helps prevent soil erosion, 28% said that the roots of Lipote helps in water absorption and prevent floods, 11% of the respondents observed that the roots of Lipote can prevent surface run-off and also flood that can lead to soil degradation and only 6% of the respondents said that the roots of Lipote helps soil maintain nutrients. According to Vannoppen *et al.* (2015), plant roots play a dominant role in controlling soil erosion rates, like gully and rill erosion, by reducing the soil detachment rate in concentrated flow.

Table 15: Uses of Lipote roots as given by the respondents

Uses of Lipote Roots	*Frequency*	*Percentage (%)*
Prevent erosion	10	56
Water absorption to prevent floods	5	28
Prevents surface run-off that leads to soil degradation	2	11
Maintain soil nutrients	1	6

Description of Natural Habitat of Lipote

Table 16 shows the natural habitat of Lipote wherein the highest percentage of the respondents (67%) said that Lipote is mostly found in low forest elevation with open canopy surrounded by grasses. Meanwhile, 11% of the respondents observed Lipote in areas near wetlands and in agricultural land with low elevation. Lastly, 6% of the remaining respondents said that Lipote can be seen in areas along riverbanks and areas with sandy and loamy soils. According to Florido and Cortiguerra (2003), Lipote grown to its natural habitat and originated primarily in low to medium altitudes in forested areas.

Table 16: Natural habitat of Lipote as observed by the respondents

Natural Habitat of Lipote	*Number of Respondents*	*Percentage (%)*
Low forest with open canopy and surrounded by grasses.	12	67
Near wetlands where the soil has high moisture	2	11
Agricultural land in low elevation areas	2	11
Along riverbanks	1	6
Areas with sandy and loamy soil	1	6

Conclusions

Based on the findings of the study, it was concluded that the observation of the respondents on the duration of development phases is not similar from the observation of the researcher wherein the researcher observed bolting to fruit fall starts from April to November while the respondents observed this from January to September. Thus, the tree is likely asynchronous, it took a total of 148 days from bud to fruit development. Findings show that Lipote bore fruit annually, either once or thrice a year, other can depending on environmental conditions. The time of fruiting is from August to September, fruit maturity from October to November and fruit fall is usually November. The respondents have broad experience and knowledge when it comes to ecological and economic benefits of Lipote within their locality, but they are also low knowledge when it comes to preserving Lipote into products that can be sold, compared to other provinces that they developed methods for processing Lipote into variety of products (jam, jelly, wine, vinegar etc.). In addition, the conservation of this species is lacking attention due to its low market value, especially in Aurora Province.

The results in the study of documenting the duration of developmental phases of Lipote are only applicable in the study site. It is recommended to conduct further studies on the documentation of Lipote outside Aurora Province, as its growth appears to be influenced by the specific environmental conditions of the locality where it is found. Local government should promote Lipote as a part of planting materials in any reforestation activities, conduct information education campaign in conserving and protecting native fruit trees and their environment to increase awareness and popularity to community and individuals who do not appreciate their value and simultaneously it can open a window for a potential income by producing food and medicine. Also, Future researchers can carry out additional research on the physicochemical value and nutritional content of the products made.

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Annexure - 1

PHENOLOGY AND PROPAGATION OF LIPOTE
(*Syzygium polycephaloides* (C.B. ROB.) MERR.)

Name (Optional): _____ Age: _____ Sex: ____
Residence: _____Contact No. _____
Classification of respondent: ☐LGU, ☐Tree owner, ☐ herbalist,
☐ DENR personnel, ☐ Fruit gatherer/users, ☐other specify, _____

DIRECTIONS: Please answer the questionnaire based on your own observation/and knowledge of the phenological description, importance and uses of Lipote (*Syzigium polycephaliodes*). Your identity will be concealed and your responses will be treated in strictly confidential.

PART 1. To determine the phenological description of *S. polycephaloides* in terms of flushing and bolting period, flowering period, fruiting period, maturity period, draw a line on the month/s you observed it to occur.

Lipote	*Jan*	*Feb*	*Mar*	*Apr*	*May*	*Jun*	*Jul*	*Aug*	*Sep*	*Oct*	*Nov*	*Dec*
Flushing/ Bolting												
Anthesis												
Flowering												
Fruiting												
Maturity/ Fruit harvest												
Fruit Fall												
Leaf Fall												
Others (leaf shedding if any, specify: _____												

Have you observed any seed year (a year of gregarious fruiting?) yes ☐ no ☐
How many years after did you observed fruits again? _____
How many years of interval did you observe after fruits again? _____
What specific soil, habitat and climatic requirements of Lipote thrives? _____
Age of tree before it bare fruits? _____
In what year did you observe a gregarious fruiting of Lipote? _____

If Lipote fruits are harvested, how many kg of fruit do you usually harvest in one season? _____

PART 2. To determine the importance and uses of Lipote ecologically and economically.

1. Based on your own experience, why do we need to conserve fruit trees like Lipote?
   _____
   _____
   _____
   _____

2. What are the usefulness of Lipote to your household, the communities and ecosystem?
   _____
   _____
   _____
   _____

3. Parts of Lipote and their respective uses

   Leaves
   _____
   _____
   _____

   Flowers
   _____
   _____
   _____

   Bark
   _____
   _____
   _____

   Roots
   _____
   _____
   _____

4. Where are Lipote trees usually located? (Specific location/Site Description)
   _____

Authors' Declarations and Essential Ethical Compliances

Author's Contributions (in accordance with ICMJE criteria for authorship)

This article is 100% contributed by the sole author. He conceived and designed the research or analysis, collected the data, contributed to data analysis & interpretation, wrote the article, performed critical revision of the article/paper, edited the article, and supervised and administered the field work.

Funding
No financial support was received for the research and writing of this article.

Research involving human bodies or organs or tissues (Helsinki Declaration)
The author(s) solemnly declare(s) that this research has not involved any human subject (body or organs) for experimentation. It was not a clinical research. The contexts of human population/participation were only indirectly covered through literature review. Therefore, an Ethical Clearance (from a Committee or Authority) or ethical obligation of Helsinki Declaration does not apply in cases of this study or written work.

Research involving animals (ARRIVE Checklist)
The author(s) solemnly declare(s) that this research has not involved any animal subject (body or organs) for experimentation. The research was not based on laboratory experiment involving any kind animal. The contexts of animals were only indirectly covered through literature review. Therefore, an Ethical Clearance (from a Committee or Authority) or ethical obligation of ARRIVE does not apply in cases of this study or written work.

Research on Indigenous Peoples and/or Traditional Knowledge
The author(s) solemnly declare(s) that this research has involved Indigenous Peoples/Knowledge as participants or respondents. The contexts of Indigenous Peoples or Indigenous Knowledge were only indirectly covered through literature review. Therefore, a prior informed consent (PIC) of the respondents or Self-Declaration in this regard is appended in cases of this study or written work.

Research involving Plants
The author(s) solemnly declare(s) that this research has not involved the plants for experiment and field studies. Some contexts of plants are also indirectly covered through literature review. Thus, during this research the author(s) obeyed the principles of the Convention on Biological Diversity and the Convention on the Trade in Endangered Species of Wild Fauna and Flora.

Research Involving Local Community Participants (Non-Indigenous) or Children
The author(s) solemnly declare(s) that this research has directly involved local community participants or respondents belonging to non-Indigenous peoples. This study has not involved any child in any form directly. The contexts of different humans, people, populations, men/women/children and ethnic people were only indirectly covered through literature review. Therefore, a a prior informed consent (PIC) of the

respondents or Self-Declaration in this regard is appended in cases of this study or written work.

PRISMA (Preferred Reporting Items for Systematic Reviews and Meta-Analyses)
The author(s) has/have NOT complied with PRISMA standards. It is not relevant in case of this study or written work.

Competing Interests/Conflict of Interest
Author(s) has/have no competing financial, professional, or personal interests from other parties or in publishing this manuscript. There is no conflict of interest with the publisher or the editorial team or the reviewers.

Attribution and Representation
All opinions and mistakes are the author(s)' own and cannot be attributed to the institutions they represent. The publisher is also not responsible either for such opinions and mistakes in the text or graphs or images.

Declaration of the Use of AI
During the preparation of this work, the author used no AI tool to assists the script translation and proof reading.

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To see original copy of these declarations signed by Corresponding/First Author (on behalf of other co-authors too), please download associated zip folder [Declarations] from the published Abstract page accessible through and linked with the DOI: https://doi.org/10.33002/nr2581.6853.080111.

SELF-DECLARATION FORM

Research on Indigenous Peoples and/or Traditional Knowledge

1. Conditions of the Research

1.1 Was or will the research (be) conducted on (an) Indigenous land, including reserve, settlement, and land governed under a self-government rule/agreement or?

No

1.2 Did/does any of the criteria for participation include membership in an Indigenous community, group of communities, or organization, including urban Indigenous populations?

No

1.3 Did/does the research seek inputs from participants (members of the Indigenous community) regarding a community's cultural heritage, artifacts, traditional knowledge, biocultural or biological resources or unique characteristics/practices?

No

1.4 Did/will Aboriginal identity or membership in an Indigenous community used or be used as a variable for the purposes of analysis?

No

2. Community Engagement

2.1 If you answered "Yes" to questions 1.1, 1.2, 1.3 or 1.4, have you initiated or do you intend to initiate an engagement process with the Indigenous collective, community or communities for this study?

No Applicable

2.2 If you answered "Yes" to question 2.1, describe the process that you have followed or will follow with to community engagement. Include any documentation of consultations (*i.e., formal research agreement, letter of approval, PIC, email communications, etc*.) and the role or position of those consulted, including their names if appropriate:

Not Applicable.

3. No Community Consultation or Engagement

If you answered "No" to question 2.1, briefly describe why community engagement will not be sought and how you can conduct a study that respects Aboriginal/ Indigenous communities and participants in the absence of community engagement.

The present study titled: "Documentation of Lipote (*Syzygium Polycephaloides* (C.B. Rob.) Merr) and Respondents Knowledge and Experience Towards Ecological and Economical Usefulness", involves community participation, however, the research participants of the present study does not belong to any Aboriginal/ Indigenous communities.

- Name of Principal Researcher: Jan Orville Pimentel Bautista
- Affiliation of Principal Researcher: School of Forestry and Environmental Science, Aurora State College of Technology – Zabali, Baler, Aurora 3200 Philippines

Signature:

Declaration: Submitting this note by email to any journal published by The Grassroots Institute is your confirmation that the information declared above is correct and devoid of any manipulation.

INFORMATION AND CONSENT FORM FROM RESPONDENTS
(Non-Indigenous Respondents)
This form was translated into local language for the respondents

Title of the Research: Documentation of Lipote (*Syzygium Polycephaloides* (C.B. Rob.) Merr) and Respondents Knowledge and Experience Towards Ecological and Economical Usefulness

Principal Researcher: Jan Orville Pimentel Bautista
School of Forestry and Environmental Science, Aurora State College of Technology – Zabali, Baler, Aurora 3200 Philippines

Research Supervisor:

A) INFORMATION TO PARTICIPANTS

1. Objectives of the research
The objectives of this study were to document the duration development of flowering phases of Lipote, to determine the duration of flushing, anthesis, flowering, fruiting and fruit fall based on the observation of the selected respondents and to document the knowledge and experience of the selected respondents in relation to economic and ecological importance of Lipote in Baler Aurora.

2. Participation in research
The researcher will ask you several pertinent questions. This interview will be recorded in written form and should last about 50-60 minutes. The location and timing of the interview will be determined by you, depending on your availability and convenience.

3. Risks and disadvantages
There is no particular risk involved in this project. You may, however, refuse to answer any question at any time or even terminate the interview.

4. Advantanges and benefits
You will receive intangible benefits even if you refuse to answer some questions or decide to terminate the interview. You will also contribute to a better understanding of the causes for protecting and conserving Lipote to their natural habitat.

5. Confidentiality
Personal information you give us will be kept confidential. No information identifying you in any way will be published. In addition, each participant in the research will be assigned a code and only the researcher will know your identity.

6. Right of withdrawal
Your participation in this project is entirely voluntary and you can at any time withdraw from the research on simple verbal notice and without having to justify your decision, without consequence to you. If you decide to

opt out of the research, please contact the researcher at the telephone number or email listed below. At your request, all information concerning you can also be destroyed. However, after the outbreak of the publishing process, it is impossible to destroy the analyses and results on the data collected.

B) CONSENT

Declaration of the participant

- ⇨ I understand that I can take some time to think before agreeing or not to participate in the research.
- ⇨ I can ask the research team questions and ask for satisfactory answers.
- ⇨ I understand that by participating in this research project, I do not relinquish any of my rights, including my right to terminate the interview at any time.
- ⇨ I have read this information and consent form and agree to participate in the research project.
- ⇨ I agree that the interviews be recorded in written form by the researcher: Yes ( ) No ( )

Signature of the participant : _____ Date : _____

Surname : _____ First name : _____

Researcher engagement

I explained to the participant the conditions for participation in the research project. I answered to the best of my knowledge the questions asked and I made sure of the participant's understanding. I, along with the research team, agree to abide by what was agreed to in this information and consent form.

Signature of the researcher :

Date : 24-01-2024

First name : Jan Orville

Surname: Bautista

- ⇨ Should you have any questions regarding this study, or to withdraw from the research, please contact For. Jan Orville Pimentel Bautista by e-mail janorvillebautista@ascot.edu.ph
- ⇨ If you have any concerns about your rights or about the responsibilities of researchers concerning your participation in this project, you can contact the San Jose, Maria Aurora, Aurora, 3202, Philippines by email bautistajanorville29@gmail.com